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## Research on Simulation of Diversion Flood Routing for Kangshang Flood Storage in Poyang Lake Region

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### Abstract

Understanding the process of diversion flood routing for flood storage is very important for lake engineering purposes to manage hydraulic structures and prevent disaster from flood, and environmental purposes to maintain lake ecosystem and landscape. A two-dimensional numerical model was developed to simulate Kangshang flood storage with erodible beds and banks composed of well sorted-sandy materials. Flood flow data were estimated based on recorded flow data using standard flood frequency analysis techniques. The simulation results were compared and the model calibrated with water surface elevation records of the previous floods. Simulation results enabled prediction of maximum current speed, water depths, submergence scenarios and land availability under different designated flood flows for riverbed assessment, development and management.

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**Keywords:** Hydraulic Model; Poyang Lake; Kangshang Flood Storage; shallow water equation;

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### 1. Introduction

During flood, the temporary structures created, and the activities being carried out get washed off, causing severe damage to human life and other property [1]. The reports of floods in different parts of the world for several decades reveal the same scenario of enormous economic damage and human sufferings[2]. Poyang Lake region, which plays important role in China economy, is one of the greatest grain production bases and industrial raw material suppliers. Meanwhile, it is also the national flood

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disaster-prone and worst affected area. At present the research on simulation of diversion flood routing for flood storage is very little in Poyang Lake region both at home and abroad [3]. Therefore, developing research on simulation of diversion flood routing for flood storage in Poyang lake region by the full use of the existing technical means and methods is important for minimizing the losses caused by floods, and information construction of flood controlling and the utilization of flood sources [4]. Taking full advantage of the characteristics of flood storage in Poyang lake region and on the basis of a comparative analysis of various flood routing methods, the hydrodynamic model was used for flood simulation studies of diversion flood routing for Kangshang flood storage in Poyang lake region.

## 2. Main Text

### 2.1. two-dimension hydraulic equation

A two-dimension model is set up to simulate the flood routing of Poyang Lake region and its diversion areas, and to quantify the flood storage and detention capacity of the wetland. As FVM can be directly used in irregular region, it's employed with unstructured mesh for area partition here. In the paper, the two-dimension shallow water equation is transformed from conservative form to discrete form. The two-dimension shallow water equation is set up by selecting water level and flow as controlling variables.

$$\begin{aligned}\frac{\partial h}{\partial t} + \frac{\partial(hu)}{\partial x} + \frac{\partial(hv)}{\partial y} &= 0 \\ \frac{\partial(hu)}{\partial t} + \frac{\partial(hu^2 + gh^2/2)}{\partial x} + \frac{\partial(huv)}{\partial y} &= gh(s_{0x} - s_{fx}) \\ \frac{\partial(hv)}{\partial t} + \frac{\partial(hv^2 + gh^2/2)}{\partial y} + \frac{\partial(huv)}{\partial x} &= gh(s_{0y} - s_{fy})\end{aligned}\quad (1)$$

When only the bed slope and friction are considered, the source and sink term  $\bar{b}(q)$  can be written as follows:

$$\frac{\partial \bar{q}}{\partial t} + \frac{\partial \bar{f}(q)}{\partial x} + \frac{\partial \bar{g}(q)}{\partial y} = \bar{b}(q) \quad (2)$$

The expression of the limited volume after dispersement of the integral in Eq. (2) is

$$A \frac{\Delta q}{\Delta t} = - \sum_{j=1}^m T(\phi)^{-1} f(\bar{q}) L^j + b_*(q) \quad (3)$$

The Osher approximate Rieman solver refer to reference [5].

### 2.2. Grid Generation

The mesh is generated using Gis to digitize the 1:10000 ground water measured data in 2006. The triangle mesh for hydraulic calculation is generated by the grid topology program. The principle of grid arrangement is to adopt as few grids to represent the trend of topography as possible, and to make sure that they are reasonably organized and gradually varied. In consideration of the landform, the location of the sewage drain outlet, Peclet value, Courant value, grid rate, and so on, the computational domain for

the Kangshang Flood Storage is composed of a nonstructural grid with 13334 units and 6940 nodal points (Fig.1).

### 2.3. Calculation parameters

The Manning coefficient  $n$  is taken as 0.022. The entering boundary for the current flux in the computational domain is given and the outflow boundary flux are  $0 \text{ m}^3/\text{s}$ . The initial water level of each unit in the computational domain takes the relative level of the lower boundary, the primary velocity of current is  $0 \text{ m/s}$ .

### 2.4. Simulation results

The last time for the diversion flood routing for Kangshang flood retarding basin are 116 hours. Flow field at 1 d, 3 d and 5 d are shown in Figs. 2, 3, and 4 respectively. It can be seen from the figures that the current flows to Kangshang safety area and Luojiaohu safety area at 4th hours. After 9 hours flooding, the current flows to Dongyuang safety area. The time of flow reaching at Luopengshang safety area and Datang safety area are 24 hours and 44 hours respectively.

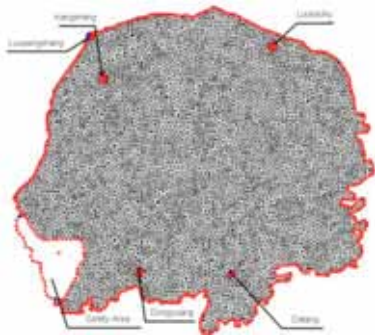


Fig. 1. Grid in Kangshang Flood Storage (left)



Fig. 2. Velocity field in Kangshang Flood Retarding Basin at 1 d (right)

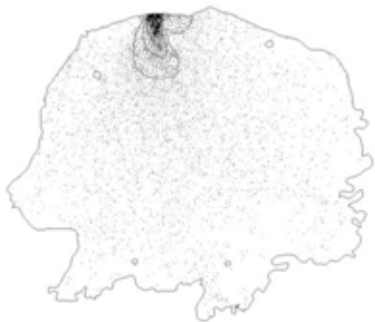


Fig. 3. Velocity field in Kangshang Flood Retarding Basin at 3 d (left)

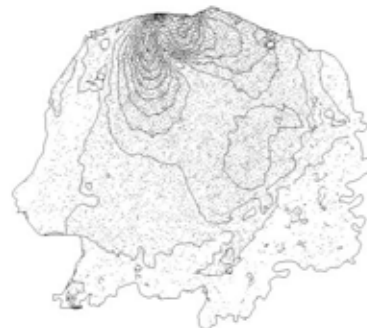


Fig. 4. Velocity field in Kangshang Flood Retarding Basin at 5 d (right)

Table 1 shows the variation of flow velocity with time in the main research areas of Kangshang flood retarding basin, and it is shown that the maximum velocity was  $5.75 \text{ m/s}$  occurring at entering boundary

about 2 hours after the beginning of simulation. There was no related recorded data could be used to verify the calculated velocity for the extreme difficulty of field measurement. After comparing with recent fragmentary field records, it is shown that the magnitude and variation process of the calculated velocity are reasonable. Total water depth was not affected at early periods for Datang safety area and Luopengshang safety area. Thereafter, total water depth was increased continuously from 2 days to 5 days. After 1 day of simulation, total water depth was significantly increased and reached a maximal value after 5 days exposure.

Table 1. Computed results of velocity field and total water depth at selected cells

| Research Areas           | 1 d   |       | 2 d   |       | 3 d   |       | 4 d   |       | 5 d   |       |
|--------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Entering boundary        | 5.606 | 2.484 | 5.510 | 4.477 | 3.861 | 5.704 | 2.066 | 8.459 | 0.635 | 9.123 |
| Kangshang safety area    | 0.312 | 2.464 | 0.175 | 5.166 | 0.063 | 6.321 | 0.023 | 8.947 | 0.012 | 9.591 |
| Dongyuang safety area    | 0.065 | 1.541 | 0.026 | 4.075 | 0.016 | 5.239 | 0.011 | 7.876 | 0.006 | 8.521 |
| Datang safety area       | 0.000 | 0.000 | 0.001 | 2.768 | 0.007 | 3.932 | 0.005 | 6.570 | 0.005 | 7.215 |
| Luojiaohu safety area    | 0.268 | 3.271 | 0.084 | 6.397 | 0.013 | 7.549 | 0.016 | 10.18 | 0.015 | 10.82 |
| Luopengshang safety area | 0.000 | 0.000 | 0.081 | 1.349 | 0.032 | 2.500 | 0.010 | 5.099 | 0.007 | 5.743 |

### 3. Conclusion

The results of the simulation have great practical meaning for the hazard assessment in Poyang lake region. From the simulated water depth distribution in the research area, the effects of diversion flood routing on the Kangshang flood retarding basin can be determined, and the economic effect of the diversion flood routing can thus be analyzed.

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